

## Critical species of Odonata in northern Africa and the Arabian Peninsula

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### ABSTRACT

The region is broadly determined by desert, which forms a huge belt between the western Palaearctic and the Afrotropics. Fourteen out of the 125 odonate species recorded so far are endemics. There are two main centres of endemism in the region: the northern Maghreb and the southern Arabian Peninsula. Odonate habitats in the desert are especially endangered by dryness and pollution. Fourteen species – most of them endemics – are regarded as critical. Conservation measures are suggested.

### REGIONAL DEFINITION

Northern Africa is broadly determined by desert. Roughly one third of the African continent is covered by the Sahara. Due to faunal affinities, the easterly adjacent Arabian Desert is here included. Both deserts are defined by less than 125 mm annual precipitation. They form a huge belt which separates the Palaearctic north and the Afrotropical south. The Sahara is northerly fringed by a semi-desert with less than 200 mm winter rain. The northernmost parts of the Maghreb are characterized by a Mediterranean climate. A semi-desert strip with less than 200 mm summer rain borders on the southern Sahara and marks the southern limit of North Africa roughly along the 15th degree of latitude. The amount of precipitation in the mountains of southwestern Arabia resembles that in the Atlas Mountains. The annual temperature in almost all parts of the region is defined as subtropical, except in the southwestern Arabian Peninsula, which is assigned to the tropics. The region contains the following African countries completely:

Morocco, Western Sahara, Algeria, Tunisia, Libya and Egypt. From Mauritania, Mali, Niger, Chad and Sudan only the Saharan sections, including Aïr, Adrar and Ennedi mountains, are taken into consideration. The Sahel in Mauritania (below 18°N), Mali (below 18°N), Niger (below 15°N) and Chad (below 15°N) as well as the Sudan parts south of Karthoum are excluded. Saudi Arabia, the Gulf Territories (Kuwait, United Arab Emirates, Bahrein, Qatar), Yemen, and Oman are the countries of the Arabian Peninsula. The Canary Islands, Madeira and the Azores in the Atlantic Ocean and Soqotra in the Indian Ocean are also included.

## STATE OF THE ART

### Studies on taxonomy, ecology and biodiversity

The checklist of Odonata in the region contains 125 taxa (R. Jödicke unpubl.). Some species – although recorded for the region – have been rejected from this checklist, since their records have been interpreted in terms of misidentification, erroneous labels or speculation, e.g. *Calopteryx syriaca* Rambur, 1842 (Dumont 1980), *Epallage fatime* (Charpentier, 1840) (Schneider & Krupp 1993), *Lestes macrostigma* (Eversmann, 1836) and *Sympetrum depressiusculum* (Selys, 1841) (Samraoui & Menaï 1999) or *Erythromma najas* (Hansemann, 1823) (Samraoui & Menaï 1999; Jödicke et al. 2000). Although huge parts of the deserts are insufficiently investigated, our knowledge of the species diversity in the region has to be judged to be rather good.

The taxonomic state of the majority of the species is well investigated, although the validity of several taxa, especially of subspecies (e.g. *Trithemis annulata scorreccii* Nielsen, 1935, *Coenagrion puella kocheri* Schmidt, 1960), is still in discussion. Samraoui et al. (2002) suggested treating *Enallagma deserti* Selys, 1871 as a subspecies of *E. cyathigerum* (Charpentier, 1840). The most recent species descriptions from the region are that of *Elattoneura khalidi* (Schneider 1988), currently assigned to the monotypic genus *Arabineura* (Schneider & Dumont 1995), and of *Lestes numidicus* (Samraoui et al. 2003). The taxonomic status of the latter is still in discussion (see Jödicke 2003). The larvae of several species, especially of the endemics, are insufficiently described or unknown.

Our knowledge about long-term changes in the distribution of Odonata is limited, with the exception of the northern Maghreb. The odonates of all other regions need much more investigation to provide a basis to judge the continuity of their distribution. North African species have been the subject of several studies in seasonality. Samraoui et al. (1998) described an interesting model of seasonality for three species in the Maghreb: immature adults of *Aeshna mixta* Latreille, 1805, *Sympetrum meridionale* (Selys, 1841) and *S. striolatum* (Charpentier, 1840) disperse into upland refuges where they postpone their sexual maturation during the dry and hot summer season. This type of estivation applies also to *S. sinaiticum* Dumont, 1977; the immature imagos spend several months in the desert. The oviposition period does not start before October and continues during the whole winter. Thus the species can, in its adult stage, live to a great individual age

**Table 1.** Selected papers dealing with odonate faunistics in northern Africa and the Arabian Peninsula.

Country/Island	Source
Azores	Navás (1933); Valle (1940); Gardner (1959, 1960); Belle & van Tol (1990); Belle (1992); Malkmus (2000)
Madeira	Hagen (1966); Valle (1940); Gardner (1960, 1962); Stauder (1991, 1995); Malkmus (2000)
Canary Islands	Bräu (1900); Navás (1906); Valle (1935, 1955); Lieftinck (1949); Gardner (1969); Belle (1982); Baez (1985); Dusoulier (1996); Kalkman & Smit (2000)
Morocco, West Sahara	Colbe (1884); McLachlan (1889); Aguesse & Prucha (1958); Lieftinck (1966); Dumont (1972, 1976); Jacquemin (1984, 1985, 1987a, 1987b, 1991, 1994); Jödicke (1995); Jacquemin & Boudot (1999); Hilfert-Rüppell et al. (1999)
Mauritania, Saharan part	Fraser (1952); Aguesse & Prucha (1958); Dumont (1976, 1978a)
Niger, Saharan part	Fraser (1950); Dumont (1978c); Martens & Dumont (1983)
Mali, Saharan part	Dumont (1977a)
Algeria	Colbe (1885); McLachlan (1897); Martin (1901, 1910); Selys (1849, 1865, 1866, 1871, 1902); Ris (1913); le Roi (1915); Lacroix (1925); Kimmins (1934); Nielsen (1956); Dumont (1978b); Samraoui et al. (1992, 1993); Samraoui & Menaï (1999); Samraoui & Corbet (2000a)
Chad	Navás (1936); Buchholz (1959)
Tunisia	Gadeau de Kerville (1908); Lacroix (1925); Dumont (1977b); Jödicke et al. (2000); Kunz & Kunz (2001)
Libya	Ris (1911); Navás (1932); Nielsen (1935a, 1935b, 1959); Kimmins (1950); Dumont (1982)
Egypt	Selys (1887); Navás (1909); Ris (1912); Andres (1928); Morton (1929); Kimmins (1950); Dumont (1973, 1974, 1980, 1991); Dumont & Fossati (1990)
Sudan, Saharan part	Dumont (1973, 1988); Dumont & Martens (1984);
Saudi Arabia	Waterston (1980); Waterston (1985); Waterston & Pittaway (1991); Schneider & Krupp (1993)
Gulf Territories	Waterston & Pittaway (1991)
Oman	Longfield (1931, 1932); Waterston (1981); Schneider (1988); Waterston & Pittaway (1991); Schneider & Dumont (1997)
Yemen	Waterston (1985); Al-Safadi (1990); Waterston & Pittaway (1991); Dumont & Al-Safadi (1991, 1993); Carfi et al. (1995); Schneider & Parr (1998)
Soqotra	McLachlan (1903); Kimmins (1961); Schneider & Dumont (1998); Schneider (1999)

of more than one year (Jödicke 2003), which is among the maximum known life-span of Odonata. In contrast to the univoltinism of the foregoing species, most other species from the northern fringe of the Tunisian Sahara are bi- or multivoltine (Jödicke 2003). Samraoui & Corbet (2000b) described the seasonal ecology of the Odonata in northeastern Algeria. An overview of the ecology and general distribution of desert-living Odonata has been given by Suhling et al. (2003).

A totally isolated occurrence of the Nearctic *Ischnura hastata* exists on the Azores and – at least formerly – Madeira. The parthenogenesis of this island population has just been confirmed (Cordero et al. 2001). This biological feature is – although well-known from the sister group *Ephemeroptera* – unique among all Odonata.

#### Faunal lists

Our knowledge about the odonate fauna of the countries within the region is rather varied. Most recent papers have been devoted to the fauna of Morocco, Algeria and Tunisia (e.g. Jacquemin & Boudot 1999; Samraoui & Menaï 1999; Jödicke et al. 2000). Odonatological research in these Maghreb countries, especially in Algeria, has a long tradition (e.g. Selys 1849). Selys (1887) also reviewed the Odonata of Egypt. During the turn of the 19th century the knowledge of the odonate fauna of northern Africa rapidly increased, caused by the colonization of the region and also by several expeditions to the Saharan oases. An early review on this period was provided by le Roi (1915). In the 1970s, H.J. Dumont started

Table 2. Endemics of the northern African and Arabian region and their ranges.

TAXON	RANGE
<i>Calopteryx exul</i> Selys, 1853	N Maghreb: Morocco, Algeria, Tunisia
<i>Azuragrion granti</i> (McLachlan, 1903)	Island: Socotra
<i>somalicum amitinum</i> (Waterston, 1991)	S Arabia: Oman
<i>Ischnura saharensis</i> Aguesse, 1958	NW Sahara: Canary IIs, Madeira, Morocco, Algeria, Tunisia, Libya, Mauritania, Niger
<i>Pseudagrion arabicum</i> Waterston, 1980	Arabia: Saudi Arabia, Yemen
<i>Arabicnemis caerulea</i> Waterston, 1984	S Arabia: Gulf Territories, Yemen, Oman
<i>Platycnemis subdilatata</i> Selys, 1849	N Maghreb: Canary Isl. (?), Morocco, Algeria, Tunisia
<i>Arabineura khalidi</i> (Schneider, 1988)	SE Arabia: Oman, Gulf Territories
<i>Aeshna yemenensis</i> Waterston, 1984	SW Arabia: Yemen
<i>Gomphus lucasi</i> Selys, 1849	NE Maghreb: Algeria, Tunisia
<i>simillimus maroccanus</i> Lieftinck, 1966	NW Maghreb: Morocco
<i>Paragomphus sinaiticus</i> (Morton, 1929)	Sahara, Arabia: Niger, Sudan, Egypt, Saudi Arabia, Oman
<i>Cordulegaster princeps</i> Morton, 1915	NW Maghreb: Morocco
<i>Sympetrum nigrifemur</i> (Selys, 1884)	Islands: Canary IIs, Madeira

systematic research that greatly improved the faunal lists of all Saharan countries. The first systematic research of Odonata in the Arabian Peninsula was conducted by A.R. Waterston, starting in the 1980s and continued by W. Schneider. Table 1 is a compilation of the most important faunistic papers for the region.

### Identification guides

No identification guide covers the whole region. The northern Maghreb is considered in Askew (1988) and in d'Aguilar & Dommange (1998). Jacquemin & Boudot (1999) provide an illustrated identification guide for all Moroccan species, which can be applied in the whole Maghreb. Dumont (1991) covers the Sinai and also provides information about adjacent regions. V. Clausnitzer & K.-D.B. Dijkstra are preparing a key for eastern Africa, which will be especially helpful in the southeastern part of the region.

## CRITICAL SPECIES

### Taxonomically isolated species

None in the region (Moore 1997).

### Species of monotypic genera confined to one country

Moore (1997) does not give an example from the region. *Arabineura khalidi* fits the definition and must be added.

### Species with an unusual biology

None is given by Moore (1997). One from the region must be added: *Ischnura hastata*, due to its parthenogenesis (see above).

### Species previously listed by IUCN

Only three species from the region are included in the IUCN Red List (Moore 1997; IUCN 2003):

#### the calopterygid *Calopteryx syriaca*

listed as 'endangered' (EN) for Egypt. The species was never recorded in Egypt (Dumont 1980). It does not belong to the fauna of the North African and Arabian region;

#### the gomphid *Paragomphus sinaiticus*

listed as 'vulnerable' (VU) for Egypt, Niger, Oman, Saudi Arabia and Sudan. This assessment is correct;

#### the libellulid *Urothemis thomasi*

listed as 'data deficient' (DD) for Oman and Saudi Arabia. It is endemic to Oman and Somalia, but has not been recorded from Saudi Arabia so far (Schneider & Krupp 1993).

## Endemism

Fourteen species are endemic to the region (Table 2). There are two main centres of endemism, the northern Maghreb and the southern Arabian Peninsula. Two of the endemics are confined to islands. Some endemics are widespread and abundant within their range; these are not included in Table 3.

Other species may also be considered endemic but a part of their ranges extend to adjacent regions: *Urothemis thomasi* occurs in Oman and also in Somalia (Carfi 1974). *Onychogomphus costae* and *Orthetrum nitidinerve* Selys, 1841 range from the Maghreb to the Iberian peninsula in Europe. Pure populations of *Cordulegaster boltonii algirica* Morton, 1915 are confined to Morocco, while the colour pattern of the population in southern Spain is more or less influenced by adjacent European subspecies (Boudot & Jacquemin 1995). *Enallagma deserti* has always been considered to be a Maghreb endemic, until its occurrence also in Ghana was brought on record (d'Andrea & Carfi 1994). However, there is some doubt about the reliability of the specimens' labels (K.-D.B. Dijkstra pers. comm.). The range of *Paragomphus pumilio* (Rambur, 1842) is limited to the Nile valley, but extends to the northern part of East Africa. *Orthetrum kollmannspurgeri* has been described from the Ennedi mountains (Buchholz 1959). Nothing is known about its range so far, and its taxonomical status urgently needs confirmation.

## Isolated or relict populations

Deserts, the Mediterranean and Red seas and the Persian Gulf are effective barriers for the distribution of Odonata. The odonate fauna in the region is mainly composed of endemics and several common afrotropical and/or palaearctic species that are highly mobile and multivoltine - important traits allowing Odonata to exist in deserts (Suhling et al. 2003). Additionally, the regional fauna also contains relict and isolated populations of species of Afrotropical, European or Asiatic origin.

## Isolated Maghreb populations of trans-Mediterranean origin

Examples from the Maghreb are relict occurrences of *Calopteryx virgo meridionalis* Selys, 1873, *C. xanthostoma* (Charpentier, 1825), *Lestes dryas* Kirby, 1890, *Enallagma cyathigerum*, *Pyrrhosoma nymphula* (Sulzer, 1776), *Aeshna cyanea* (O.F. Müller, 1764), *Oxygastra curtisii* (Dale, 1834), and *Sympetrum sanguineum* (O.F. Müller, 1764). *Lestes sponsa* (Hansemann, 1836) and *Cordulia aenea* (Linnaeus, 1758) must be treated as extinct in Africa.

## Isolated Maghreb populations of trans-Saharan origin

Relict populations of *Pseudagrion s. sublacteum* (Karsch, 1893) have been recorded in northern and central Morocco. The Lac Bleu, an element of the lake district in Numidia/NE Algeria, contains relict populations of two Afrotropical species, *Urothemis edwardsii* (Selys, 1849) and *Acisoma panorpoides ascalaphoides* Rambur, 1842. Both species are rare and threatened, but are still present. A population of *Rhyothemis semihyalina* (Desjardins, 1832) at this site is considered to be extinct within the last 150 years.

Table 3. List of critical species from northern Africa and the Arabian Peninsula. DD: data deficient; RR: range restricted; IC: identity of species needs clarification; A: action recommended, because of habitat destruction.

Family/species	DD	RR	IC	A	Distribution and notes
Calopterygidae					
<i>Calopteryx exul</i> Selys, 1853	○	●	○	○	Endemic to N Maghreb (Morocco, Algeria, Tunisia); severely declining in Algeria
Lestidae					
<i>Lestes numidicus</i> Samraoui, Weekers & Dumont, 2002	●	●	●	○	Described from Algeria; a second taxon within the <i>Lestes virens</i> complex, defined by its pattern of seasonality and rDNA analysis
Coenagrionidae					
<i>Azuragrion granti</i> (McLachlan, 1903)	●	●	○	○	Endemic to Soqotra
<i>Azuragrion somalicum amitimum</i> (Waterston in Waterston & Pittaway, 1991)	●	●	●	○	Endemic to SE Arabia (Oman); subspecific assignation needs confirmation; nominotypical ssp. confined to Ethiopia and Somalia
<i>Ischnura hastata</i> (Say, 1849)	○	●	●	○	Parthenogenesis is unique amongst all Odonata
<i>Pseudagrion arabicum</i> Waterston, 1980	●	●	○	○	Endemic to SW Arabia (Saudi Arabia, Yemen)
Protoneuriidae					
<i>Arabineura khalidi</i> (Schneider, 1988)	●	●	○	○	Endemic to SE Arabia; species of a monotypic genus confined to Oman
Aeshnidae					
<i>Aeshna yemenensis</i> Waterston, 1984	●	●	○	○	Endemic to SW Arabia
Gomphidae					
<i>Gomphus lucasi</i> Selys, 1849	○	●	○	○	Endemic to NE Maghreb (Algeria, Tunisia); population declining
<i>Gomphus simillimus maroccanus</i> Lieftinck, 1966	○	●	○	○	Endemic to NW Maghreb (Morocco)
<i>Onychogomphus costae</i> Selys, 1885	○	●	○	○	confined to the Maghreb (Morocco, Algeria, Tunisia) and the Iberian Peninsula; population declining
<i>Paragomphus sinaiticus</i> (Morton, 1929)	●	●	○	○	Endemic to Sahara and Arabian desert; known from only a few localities in Niger, Mali, Egypt, Saudi Arabia, Oman
Cordulegastridae					
<i>Cordulegaster princeps</i> Morton, 1915	○	●	○	○	Endemic to N Maghreb (Morocco)
Libellulidae					
<i>Orthetrum kollmannspergeri</i> Buchholz, 1959	●	?	●	○	Endemic to Chad?
<i>Sympetrum nigrifemur</i> (Selys, 1884)	●	●	○	○	Endemic to Canary Islands and Madeira
<i>Urothemis thomasi</i> Longfield, 1932	●	●	○	○	Confined to the Arabian desert (Oman) and Somalia

### Relict populations in the Sahara

The sub-Saharan *Pseudagrion hamoni* Fraser, 1955 survives in permanent water-bodies in Tassili-n-ajjer/Algeria and in the Fezzan/Libya.

### Isolated populations of Asian origin

*Lindenia tetraphylla* (Vander Linden, 1825) has reached Algeria (150 years ago) and Tunisia (recent records). A Levantine species, *Agriocnemis sania* Nielsen, 1959, has been found in Gat/Libyan Sahara (now extinct there) and Sinai; it also occurs in Ethiopia and Kenya. Examples of relict populations of Asiatic faunal elements in Oman are *Agriocnemis pygmaea* (Rambur; 1842), *Pseudagrion decorum* (Rambur, 1842) and *Trithemis pallidinervis* (Kirby, 1889).

### Isolated Arabian populations of Afrotropical origin

Examples are *Rhyothemis semihyalina* (Desjardins, 1832) in Oman and *Azuragrion vansomereni* (Pinhey, 1956) in Saudi Arabia. The latter is extirpated from that country now, due to the destruction of its habitat, the Laila Lakes (Krupp et al. 1990; Schneider & Krupp 1993).

### Regional Red Lists

Only for Morocco has there been published a Red List of endangered Odonata (Jacquemin & Boudot 1999). The first category 'espèces rares' contains 15 species that are rare in Morocco. The following West-Palaearctic species of this category are, in Africa, confined to the Maghreb: *Calopteryx virgo meridionalis*, *Lestes dryas*, *Pyrrhosoma nymphula*, *Enallagma cyathigerum*, *Oxygastra curtisii* and *Sympetrum sanguineum*. From the African point of view these species are extremely rare and should be included in a hypothetical North African Red List. However, the most of them are common in Europe, only *O. curtisii* being rare and limited to southwestern Europe (Sahlén et al. 2004). Other potential candidates for this list are mentioned above.

## CRITICAL SITES AND THREATS

Most of the northern African aquatic habitats are highly isolated, susceptible to drying out, pollution and regulation. Overextraction of ground water for human purpose and hence the increasing drought are general threats for the odonate fauna of the region. Overgrazing is another general problem that directly degrades odonate habitats.

In northern Africa and Arabia several nature reserves and national parks are protected which also include wetlands. The efficiency of nature protection is generally low. Significant examples are the death of Lac Noir in Algeria, formerly a famous Odonata site (Bélair & Samraoui 1994) or the threat of Lac des Oiseaux (Samraoui et al. 1992). Other examples are the Laila Lakes, the only natural freshwater lakes on the Arabian Peninsula. The lakes were an excellent Odonata site

still in 1981 (Waterston 1985), but have been destroyed subsequently due to drought, pumping for irrigation and introduction of fish (Krupp et al. 1990). Severe pollution is increasingly affecting the springs and oueds (wadis). Therefore lotic species, e.g. gomphids and calopterygids, are at severe risk. One of many examples is the Tozeur oasis with a dramatic pollution of its irrigation water: in June 2002 we established the fact that the main irrigation ditch was strongly infected by the unfiltered sewage of a tourist hotel, just 400 m behind both pump stations. Woodlands – an important habitat of maturing, feeding and aestivating Odonata – are increasingly degraded, e.g. by deliberate fires.

On the other hand, there are also pleasant examples for a beginning access to nature conservation. In the Moroccan Sidi Bou Ghaba Reserve, near Qenitra, a small “Nature Museum” presents flora and fauna and explains the ecosystem function. In March 2003 we observed a group of school children visiting the reserve, lead by members of a permanent team. In another Moroccan reserve at the mouth of oued Massa, which is now really hemmed in by houses, the important habitats are guarded by the staff of the reserve.

## CONSERVATION PRIORITIES AND RECOMMENDATIONS

The future protection of northern African and Arabian Odonata and their habitats requires environmental training of the entire local population but especially of all persons who are concerned with nature protection. The most important aims are avoidance of water pollution and protection of all isolated water habitats in the desert.

## RESEARCH PRIORITIES

Almost all data from Libya goes back to the 1950s, and there are almost no recent data from true desert waters in the Sahara countries since the research by Henri Dumont in the 1970s (e.g. Dumont 1977a, 1978a, 1978b, 1978c, 1982), so new Odonata surveys are urgently needed from these regions. All open questions regarding the taxonomic assignment of the odonate species and subspecies in the region should be clarified. We need a complete key to identify the larvae and exuviae of all species. All endemics in the region with a limited range should be regularly monitored with regard to their status and habitat use.

## CURRENT ACTIVITIES

Bernd Kunz is still busy with a mapping project in Tunisia. New records from Morocco will be the result of occasional holiday trips. A mapping project of Algeria is conducted by the University of Annaba, headed by Boudjema Samraoui. Wolfgang Schneider continues to survey the Odonata in the Arabian peninsula.

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